Clouds Second Image Report

MCEN 4151

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Introduction
Clouds can form in an infinite number of shapes and sizes, although some may look similar, each formation occurs within a particular environmental setting. Factors such as altitude, moisture content of the air, and the stability of the atmosphere all play a role in what clouds will form in the sky. Throughout the semester, I have been scanning the sky for interesting cloud phenomena. In particular, phenomena that are not seen in the everyday sky's of Colorado, for this second cloud image, I wanted to capture something truly unique.

Figure 1: Final Cloud Image (altocumulus lenticular duplicitous)

For the second and final of two required cloud image assignments, a rare cloud in the sky's of Colorado was captured and displayed above in Figure 1. This beautiful cloud is an altocumulus lenticular duplacadus with a stratus background, and the environment in which it was formed is outlined below.

Image Setting
This image was taken in Fort Collins, on October 14th facing west, looking upwards at about 15 degrees from horizontal. The time was roughly 10:00 am, as the sun was well into the sky, offering great lighting. Although most of the sky was the typical partly cloudy scenery on this beautiful Colorado summer day, there were interesting pockets of cloud formations scattered throughout the sky. On the ground, at an elevation of roughly 1500 meters the air was calm, but the motion of the clouds suggested some local uplifting of air pockets.

The Clouds
The weather for the days surrounding the image was fairly calm. No major rains, or storms within the days surrounding the image was taken. At least nothing more than a few spotty rain showers, leading me to believe the atmosphere was relatively stable during the time of the photograph. With altocumulus cloud elevation being roughly 2000-6000 meters from the ground surface it is classified as a mid-level cloud. The formation looked very calm, looking at the skew-T plot shown below in Figure 2, the winds are shown to pick up at roughly 4500 meters, leading me to believe that the depicted clouds in Figure 1 reside between 2000 meters and 4500 meters, making them relatively lower altocumulus lenticular clouds. Cumulus clouds tend to occur in layers or patches, the cloud displayed above in Figure 1 took on a unique layered formation, ideal for cloud viewers. The cloud formation was extremely dense and this cloud patch stretched a great distance along the Continental Divide. The Continental Divide plays a

major role in the formation of this type of cloud. As air moves over the mountains, it gets pushed upwards, the air then begins to fall back down the backside of the mountains creating large scale standing wave than begins to oscillate throughout the sky.These lenticular cloud formations are located at the top of these orographic standing waves. This effect is outlined below in Figure 2.

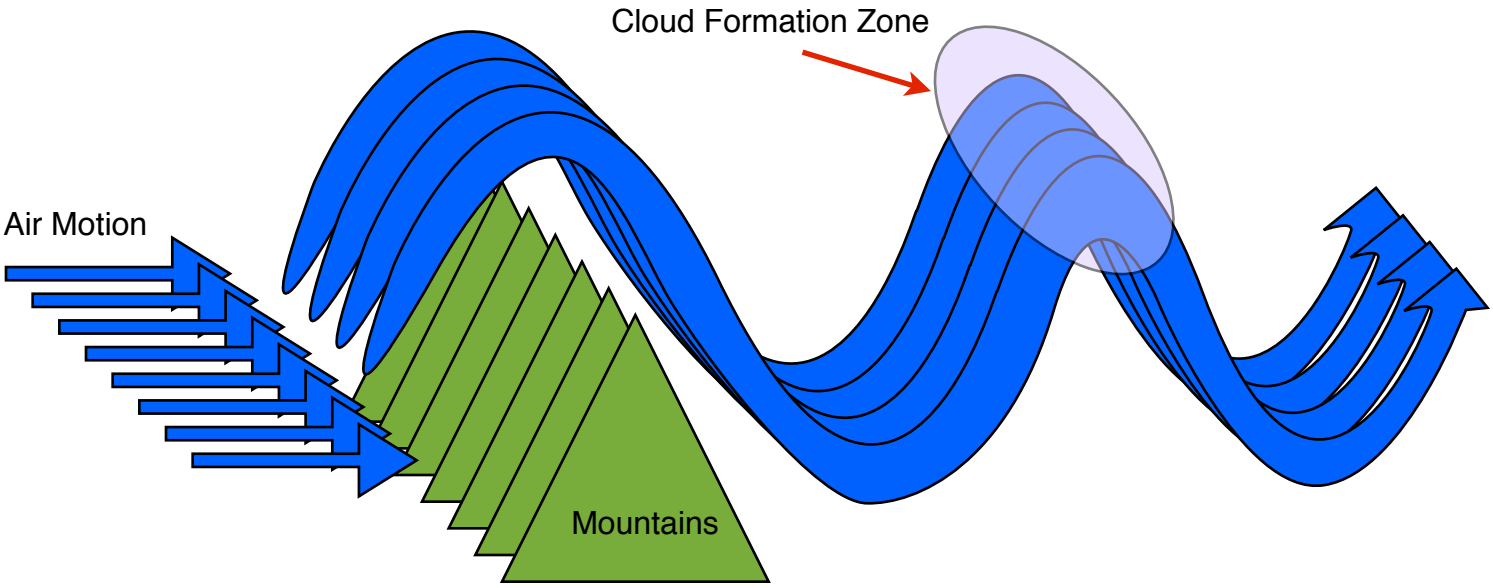

Figure 2: Orographic standing wave description

This formation can also be enhanced by the effects of the sun and earth. The top of the clouds reflect light and cool while the cloud bottoms absorb IR light from the earth, and warm. Cool on top and warm on the bottom leads to instability thus causing the air to want to turn over, breaking up stratus layer causing the unique uplift of the cloud from the inside and creating the hallow pocket. This motion plus the standing wave created by the mountains, creates a perfect storm, further enhancing the unique lensed shape of the clouds.

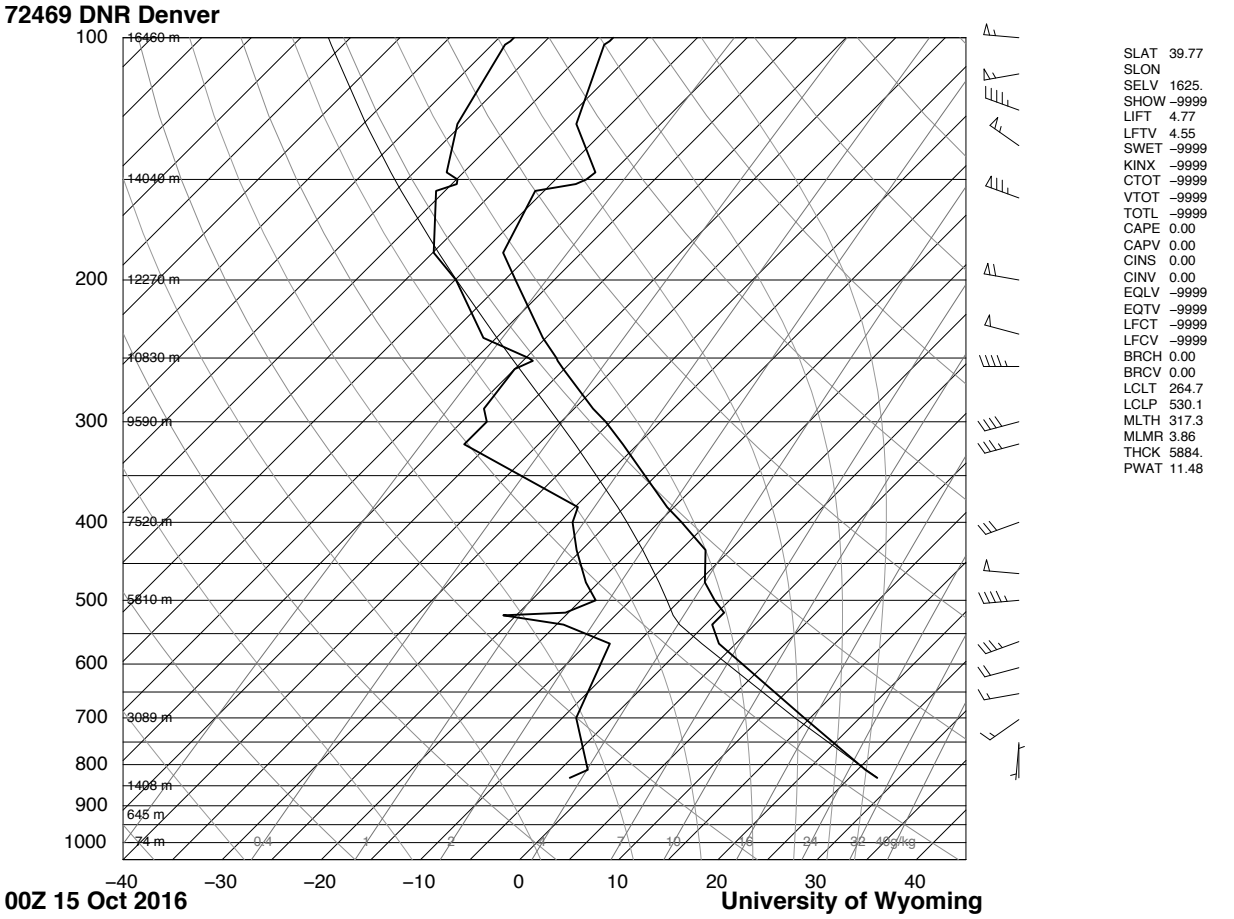

Figure 3: Skew-T plot (6am Oct. 14, 2016)

Shown above in Figure 3, is the Skew-T plot for the morning of the photograph. Although this weather balloon is flown at DIA at 6:00am, the information is close enough to get a decent idea of what is going on in the atmosphere during the time of the photograph. At roughly the elevation of the cloud, the wind is blowing very softly to the east. The CAPE value being zero also suggests a fairly stable atmosphere, more evidence of this cloud being an altocumulus cloud. Cumulus, meaning joined together, alto, meaning high, and duplicitous, signifies the formation of more than one cloud with the same shape.

Camera

Sadly only my iPhone 6s was available during the sighting of this beautiful cloud. Despite the lack of appropriate camera equipment, I was able to obtain the image displayed below in Figure 3. Clouds are also always in motion, changing and developing over time, this motion gives small time windows in which you are able to capture their natural beauty. Because I was on a brewery tour, I didn't have the time to mobilize to obtain an ideal image, but letting these clouds slip away would have been a true

travesty. Luckily, the cameras that are on cell phones these days are incredible. My phone was able to obtain an ISO of 25, f-stop of 2.2, a shutter speed of 1/1148 second.

Figure 4: Original unedited image

The original image shown above in Figure 4 was edited using Gimp. The image was cropped and unwanted features such as the light post and trees were removed, resulting in the final image shown in Figure 1. According to my height and camera angle estimations, the cloud was about 15000-20000 meters away and roughly 4000 meters in diameter. Giving a rough field of view of 3000-5000 meters horizontally and pixel dimensions of 4032 X 3024.

Conclusion

This image shows some interesting cloud physics. The cloud was likely by air being pushed upward because of the presence of a mountain range. Removing so much information from the image at first was daunting, but realizing that all of the important physical information remained unaltered, I am happy with the final product. Although the intent was fulfilled in capturing a truly unique cloud for the state of Colorado, I wish I had my camera with me, rather than just my phone. Despite the fact that this class will be over, for future cloud images, I will use this knowledge to build my own gallery of beautiful images.

Citations:

Skew-T:
Oolman, Larry. "Atmospheric Soundings." *Atmospheric Soundings*. University of Wyoming, 15 Oct. 2016. Web. 11 Dec. 2016. <http://weather.uwyo.edu/upperair/sounding.html>.

Cloud information:
Met Office. "CM4 Altocumulus continually changing shape — lenticular altocumulus" *Cloud Types for Observers*. London: H.M.S.O., 1982. pg. 20-23. *Cloud Types for Observers*. Met Office, 2006. Web. 12 Dec. 2016. <http://www.metoffice.gov.uk/media/pdf/r/i/Cloud_types_for_observers.pdf>.